REFLECTIONS OF A PHYSICIST

FRANK H. SHELTON

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SUBJECT: BOOK

DEAR Harold:

ENCLOSED FOR YOUR READING PLEASURE IS A BOOK - "REFLECTIONS OF A PHYSICIST". I WROTE THE MANUSCRIPT FOR THE BOOK FROM A VARIETY OF NOTES THAT I HAD MADE IN VARIOUS NOTEBOOKS, SOME AS LONG AS 50 YEARS AGO, AND SOME OF THE NOTES ARE RECENT.

THE BOOK CONTAINS TWELVE CHAPTERS IN WHICH THERE ARE ITEMS OF PHYSICS IN EACH CHAPTER THAT GENERALLY BEAR ON A GIVEN SUBJECT. THE TEST IS PEPPERED WITH "EXERCISES FOR THE READER" THAT ARE USUALLY FOLLOWED WITH A SOLUTION OF THAT PROBLEM. THE GENERAL OBJECTIVE OF THE BOOK IS TO ACQUAINT THE READER WITH HOW A PHYSICIST MIGHT THINK ABOUT A TECHNICAL TOPIC INVOLVING A WIDE RANGE OF PHYSICS.

THERE IS A GENERAL BIAS TOWARDS RELATING SOME OF THE TOPICS TO NUCLEAR WEAPON PHYSICS, A SUBJECT IN WHICH I HAVE BEEN ENGAGED FOR OVER 50 YEARS.

WHILE I AND OTHERS HAVE PROOF-READ THE BOOK SEVERAL TIMES, THERE ARE UNDOUBTEDLY SOME REMAINING ERRORS. IF YOU FIND AN ERROR OR ERRORS, PLEASE FORWARD YOUR FINDING AND I WILL ATTEMPT TO CORRECT THE TEXT FOR A 2ND EDITION - OR I MAY SEND TO READERS A CORRIGENDA.

SINCERELY,
Frank H. Shelton
FRANK H. SHELTON

ENCLOSURE: BOOK - "REFLECTIONS
OF A PHYSICIST"

I want to thank you for your assistance in correcting some of my text in the book: "Hiroshima-Nagasaki Bombing Missions"
I think the enclosed book: "Reflections of A Physicist" is most probably more to our common interests and thoughts. Anyway, trust you will find items of current interest such as the material on pages 174-175. Sometime give me your thoughts on that subject - & teller's claim that it was Carvin that gave him that magnificent idea.

PROTONS AND THE EARTH'S MAGNETIC FIELD

Consider an ARGUS type nuclear device detonation. There is a major source of protons from fission neutrons, that is from a boosted fission implosion device with modern design and the subsequent decay of spectrum neutrons.

$$n \Rightarrow p^+ + e^- + \nu + 0.783 \text{ MeV} \ .$$

Fission weapons have about 3.4×10^{23} neutrons per kiloton of yield, and there are significant numbers neutrons/MeV with energy between 1 MeV to 10 MeV. Consider a 5 MeV proton, and determine its gyro radius at the magnetic equator on L = 2.236 (B_θ = 0.0279 G):

$$\rho = \frac{mv\perp c}{(Ze)B} = \frac{5 \text{ MeV} \times 1.6 \times 10^{-6} \text{ ergs / MeV}}{1 \times 4.8 \times 10^{-10} \text{ esu} \times 2.79 \times 10^{-2} \text{ G}}$$

$$\rho = 0.6 \times 10^6 \text{ cm} = 6 \times 10^3 \text{ m} = 6 \text{ km} \ .$$

These protons migrate WESTWARD from the initial "banana" tube.

$$mv\perp c = Moc^2 \ v/c = 938 \text{ MeV } v/c = 5 \text{ MeV}; \quad v/c = 5/938 = 5.33 \times 10^{-3}$$

$$v\perp = 1.6 \times 10^8 \text{ cm s}^{-2}; \quad \omega = v/\rho = 2.7 \times 10^2 \text{ s}^{-1}$$

$$T = 2\pi/\omega = 2.3 \times 10^{-2} \text{ s rev}^{-1}; \quad \upsilon = 1/T = 0.43 \times 10^2 \text{ rev s}^{-1} \ .$$

It has been observed that at the time of a Solar geomagnetic storm, the intensity of protons in the energy from 0.1 to 4.5 MeV at a distance of about 3 to 4.5 Earth radii (outer Van Allen Belt) increased by a factor of about 3. These protons are trapped in the Van Allen outer radiation belt at about 3.5 Earth radii and drift west under the influence of the Earth's magnetic field. Find the gyromagnetic radius of a 4.5 MeV proton in the Van Allen radiation belt:

$$B_\theta = \frac{B_o r_o^3 \text{ Sin } \theta}{r^3} = \frac{0.312 \times 1^3 \times 1}{(3.5)^3} = 7.3 \times 10^{-3} \text{ G}$$

$$\rho = \frac{4.5 \times 1.6 \times 10^{-6}}{4.8 \times 10^{-10} \times 7.3 \times 10^{-3}} = 2 \times 10^6 \text{ cm} = 20 \text{ km} \ .$$

The energies of primary protons in cosmic rays cover a considerable range and, in general, the intensity increases with decreasing energy. The presence of protons with the extraordinarily high energy of a billion tron volts, 10^{18}, has been inferred in GALACTIC cosmic rays, and the average energy per proton is estimated be above 10 billion (10^{10} ev) electron volts.

The gyromagnetic radius ρ of the helical path of a particle of mass m, charge Ze, moving in a magnetic of strength B, and having a velocity component $v\perp$ to the field is –

$$\rho = \frac{mv\perp c}{(Ze)B} \qquad (c = \text{velocity of light}) \ .$$

The gyromagnetic radius of a proton will be about 1,840 times that of an electron with the same velocity. of high energy protons may follow a spiral path of such large radius as to bring them below 650 km altitude the course of their gyrations and will likely collide with air molecules. Such high energy protons will tend ESCAPE the geomagnetic trap and will disappear with energetic collisions with air nuclei and will form cosmic ray "showers." From the above equation for gyromagnetic radius, ρ, it is seen that the radius is decr when the field strength, B, is increased. Hence, energetic protons can remain trapped only in parts of the belt near the Earth because the geomagnetic field is then relatively strong. At greater distances, only por low energy, with relatively small gyromagnetic radii, can be prevented from escaping in the manner desc